

## Notes on systematics of the *Erebia dabanensis* species complex, with special consideration of the *dabanensis*–*youngi* and *anyuica*–*occulta* pairs of sibling species (Nymphalidae: Satyrinae)

ALEXEI G. BELIK\* & DMITRY G. ZAMOLODCHIKOV\*\*

\* P. O. Box 1594, RU-410028 Saratov, Russian Federation. e-mail: belik@san.ru

\*\* Forest Ecology and Production Center RAS, Novocheremushkinskaya, 69, RU-117418 Moscow, Russian Federation. e-mail: dzamolod@cepl.rssi.ru

**Summary.** There are two pairs of closely related taxa in the *Erebia dabanensis* species complex which deserve special attention. These pairs are: *Erebia dabanensis* Erschoff, 1871 – *E. youngi* Holland, 1900; and *E. anyuica* Kurentzov, 1966 – *E. occulta* Roos & Kimmich, 1983. Relationships of the taxa within these pairs are analysed. A study of the comparative morphology of the male genitalia demonstrates that each discussed taxon is a distinct species. This conclusion is supported by statistically significant differences in the size proportions of the valvae in the male genitalia, as well as by results of a cluster analysis. For the first time, two putatively endemic Nearctic species, i.e. *E. youngi* and *E. occulta*, are discovered in the Palaearctic region, at Northeast Chukotka, thus revealing trans-Beringian distributions in both cases. All previous records of *E. occulta* in the Palaearctic refer to *E. anyuica*. The use of the name *E. anyuica* Kurentzov, 1966 constitutes a considerable problem. This is because of the somewhat obscure original description, while the single type specimen (holotype by monotypy) might be lost. The name *E. anyuica* Kurentzov, 1966 should preferably be used for the endemic Palaearctic species, previously considered as conspecific with *E. occulta*, until a thorough re-investigation of the Kurentzov collection has been performed. Only then the holotype may be rediscovered or a neotype will be validly designated. The recent designation of a neotype of *E. anyuica* (Korb 1999) is considered invalid, as it does not meet the requirements of the ICZN.

**Zusammenfassung.** Zwei Artenpaare aus dem *Erebia-dabanensis*-Komplex werden detailliert untersucht: *Erebia dabanensis* Erschoff, 1871 – *E. youngi* Holland, 1900 sowie *E. anyuica* Kurentzov, 1966 – *E. occulta* Roos & Kimmich, 1983. Eine vergleichend-morphologische Studie der männlichen Genitalapparate belegt, daß alle vier Taxa als distinkte Morphospezies anzusehen sind. Dies wird durch statistisch signifikante Unterschiede in Genitalmaßen wie auch durch Befunde einer Clusteranalyse belegt. Erstmals werden zwei zuvor als endemisch-nearktische Taxa angesehene Arten (*E. youngi*, *E. occulta*) aus der Paläarktis (von der nordöstlichen Tschuktschen-Halbinsel) gemeldet. Diese beiden Arten haben demnach trans-beringische Verbreitungsareale. Alle früheren Meldungen von *E. occulta* aus der Paläarktis betreffen in Wirklichkeit *E. anyuica*. Der Taxonname *E. anyuica* Kurentzov, 1966 ist problembehaftet, da die Originalbeschreibung wenig präzise und der Holotypus möglicherweise verschollen ist. Solange nicht durch gründliche Recherche im Originalmaterial von Kurentzovs Sammlung genaueres über das Schicksal des Holotypus bekannt ist, sollte der Name *E. anyuica* Kurentzov, 1966 nur für die in der Paläarktis endemische Art verwendet werden, die bis vor kurzem als konspezifisch mit *E. occulta* angesehen wurde. Nur dann könnte der Holotypus wiederentdeckt werden oder ein Neotypus festgelegt werden. Die rezente Festlegung des Neotypus von *E. anyuica* (Korb 1999) wird als ungültig angesehen, da sie nicht den internationalen Nomenklaturregeln entspricht.

**Résumé.** Le complexe d'espèces d'*Erebia dabanensis* comprend deux paires de taxons qui méritent une attention particulière, à savoir *Erebia dabanensis* Erschoff, 1871 – *E. youngi* Holland, 1900 et *E. anyuica* Kurentzov, 1966 – *E. occulta* Roos & Kimmich, 1983. Les liens de parenté des taxons au sein de ces paires sont analysées. Une étude morphologique comparative des génitalia mâles démontre que chacun des taxons discutés constitue une espèce distincte. Cette conclusion est fondée sur des différences statistiquement significatives au niveau des proportions quantitatives des valves, ainsi que sur les résultats d'une analyse de cluster. Pour la première fois, deux espèces jusqu'à présent supposées être des endémiques néarctiques, à savoir *E. youngi* et *E. occulta*, ont été découvertes dans la région paléarctique, dans le nord-est de la région de l'Anadyr, révélant ainsi des aires de répartition transbéringiennes dans les deux cas. Toutes les mentions précédentes d'*E. occulta* de la région paléarctique s'appliquent à *E. anyuica*. L'usage du nom *E. anyuica* Kurentzov, 1966 pose un problème considérable, à cause de la description originale quelque peu obscure, alors que le spécimen-type unique (holotype par monotypie) pourrait être perdu. Il est préférable, à l'heure actuelle, d'utiliser le nom *E. anyuica* Kurentzov, 1966

pour désigner l'espèce paléarctique endémique, précédemment considérée comme étant conspécifique avec *E. occulta*, jusqu'à ce qu'une nouvelle étude approfondie de la collection de Kurentzov ait été entreprise. Alors seulement l'holotype pourrait être redécouvert ou, le cas échéant, un néotype pourrait être désigné valablement. La désignation récente d'un néotype pour *E. anyuica* (Korb 1999) est considérée comme étant invalide, vu qu'elle ne correspond pas aux conditions imposées par le Code.

**Резюме.** В комплекс видов *Erebia dabanensis* входят, в частности, две пары близкородственных таксонов, которые заслуживают специального рассмотрения. Эти пары: *Erebia dabanensis* Erschoff, 1871 – *E. youngi* Holland, 1900 и *E. anyuica* Kurentzov, 1966 – *E. occulta* Roos et Kimmich, 1983. Проанализированы взаимоотношения таксонов в данных парах. Изучение сравнительной морфологии гениталий самцов показывает, что каждый из обсуждаемых таксонов является самостоятельным видом. Такой вывод подтверждается как проверкой статистической достоверности различий в пропорциях валв гениталий самцов, так и результатами кластерного анализа. Впервые два эндемичных неарктических вида *E. youngi* Holland, 1900 и *E. occulta* Roos et Kimmich, 1983 обнаружены в Палеарктике, на северо-востоке Чукотки. Все предыдущие указания на находки *E. occulta* в Палеарктике относятся к виду *E. anyuica*. Показано, что использование названия *E. anyuica* Kurentzov, 1966 представляет значительную проблему. Это связано и с недостаточно детальным описанием вида, и с тем, что единственный типовой экземпляр (голотип по монотипии) мог быть утерян. Тем не менее, представляется предпочтительным использовать название *E. anyuica* Kurentzov, 1966 для эндемичного палеарктического вида, прежде считавшегося конспецифичным с *E. occulta*, до тех пор, пока не будет переисследована коллекция Куренцова. Тогда станет возможным либо обнаружить голотип, либо произвести валидное обозначение неотипа. Недавняя попытка обозначения неотипа *E. anyuica* (Korb 1999) признается недействительной как не соответствующая требованиям МКЗН.

**Key words.** *Erebia*, sibling species, taxonomy, Chukotka, Beringian distributions.

In the present paper we attempt to clarify the systematics of the *Erebia dabanensis* complex in its most complicated and confused part. We specifically ask whether each taxon in the two pairs *dabanensis*–*youngi* and *anyuica*–*occulta* is in fact a separate species, or the taxa in these pairs are conspecific.

In July 1998, the second author visited the interior region of the Chukotskiy Peninsula (Northeast Chukotka, Russia) near the lake Ioni (65°48' N, 173°22' W). There he collected two species of the genus *Erebia* Dalman, 1816, which apparently belonged to the *Erebia dabanensis* complex. After thorough examination and comparative study these species turned out to be *Erebia youngi* Holland, 1900 and *Erebia occulta* Roos & Kimmich, 1983. This is the first proven record in the Palaearctic region of these two putatively endemic Nearctic species, as demonstrated below.

## 1. *Erebia dabanensis* Erschoff, 1871 (= *E. tundra* Staudinger, 1887) and *Erebia youngi* Holland, 1900.

### 1.1. Introduction

There is a long-standing discussion in the literature about the relationships between *E. dabanensis* and *E. youngi*: whether the latter taxon is conspecific with the former one, as well as whether these taxa are sympatric or allopatric (Warren 1936, 1969, 1981; dos Passos 1972; Troubridge & Philip 1983; Scott 1986; Tuzov *et al.* 2000). Because of the great phenetic similarity of *E. youngi* with *E. dabanensis*, it is often impossible to identify specimens of these taxa on the sole basis of details of the wing pattern and coloration, without studying the male genitalia.

*Erebia tundra* Staudinger, 1887 is a junior subjective synonym of *E. dabanensis* Erschoff, 1871 (see Belik, *in press*). Kurentzov (1970) considered *E. tundra* as a sepa-

rate species, distributed at the Northeast of Eurasia from East Yakutiya to East Chukotka, but he appears to have been confused completely about the taxonomy of the *E. dabanensis* species complex. His figures for the male genitalia of *E. dabanensis* and *E. tundra* match the genitalia structure of *E. kozhantshikovi* Sheljuzhko, 1925, and vice versa. Kurentzov's key to *Erebia* (using wing pattern and coloration only) is inconsistent for these three taxa. Thus, it is impossible to decide what Kurentzov meant by the name "*E. tundra*". After the publication of Kurentzov's book (1970) the systematics of the *E. dabanensis* species complex remained confused completely for a while. Accordingly, in some later publications *E. tundra* was considered as a separate species, too (Korshunov 1972; Kogure & Iwamoto 1993).

Troubridge & Philip (1983) convincingly demonstrated that *E. dabanensis* and *E. youngi* are two different species, separated well by the stable differences in the male genitalia structure. They also proved that in the Nearctic only *E. youngi* occurs, with all previous records of *E. dabanensis* from North America referring actually to *E. youngi*. In the literature, no records exist about *E. youngi* occurring in the Palaearctic. Thus, it was concluded that *E. dabanensis* and *E. youngi* are two closely related allopatric species, with the Bering Strait as natural boundary between their areas of distribution.

With our discovery of *E. youngi* in the Palaearctic the problem of the relationship with *E. dabanensis* came up again, since both taxa are sympatric in the East Palaearctic. Specifically, the possible occurrence of a cline in the male genitalia structure from *E. dabanensis* to *E. youngi* within the Palaearctic part of the range could not be excluded.

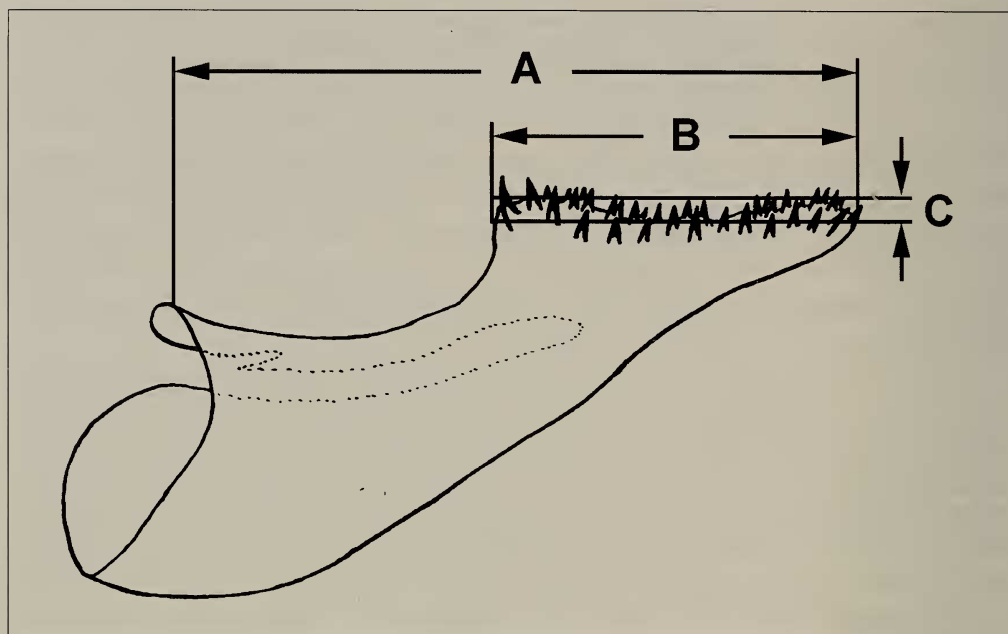
## 1.2. Material examined and methods

6♂ Canada, Yukon Territory: Nickel Creek; 1♂ Richardson Mts., Windy pass; 5♂ Russia, NE. Chukotka, 20 km SE of lake Ioni, valley of Gil'mimleveyem river; 10♂ Russia, NW. Chukotka, Bilibino district, 5–20 km NW of Bilibino; 10♂ Russia, Magadan region: Khasyn district, vicinity of Palatka; 3♂ Bol'shoy Anngachak mtn. range, vicinity of the Jack London lake; 10♂ Russia, Chita region, Udokanskiy mtn. range, 20–26 km SE of Udokan, upper stream of Naminga river; 10♂ Russia, Chita region, Kyra district, ca. 67 km WNW of village Kyra, Sokhondo Mts., upper stream of Bukukun river; 9♂ Russia, Buryat republic, East Sayan Mts.: Tunkinskiye Gol'tsy mtn. range, Mt. Khulugaysha; 1♂ Kitoyskiye Gol'tsy mtn. range, between the sources of Irkut and Kitoy rivers, vicinity of Il'chir lake; 1♂ Russia, Krasnoyarsk territory, Taymyr autonomous region, Putorana plateau: vicinity of Talnakh; 5♂ ca. 100 km E of Noril'sk, E. extremity of the lake Lama; 10♂ Russia, Tyumen' region, Yamal-Nenets autonomous region, Polar Ural Mts., 10–20 km NW of Kharp.

To distinguish *E. dabanensis* and *E. youngi*, Troubridge & Philip (1983) introduced a method to compare the length of the spined ridge of the valvae (in the male genitalia) expressed as per cent ratio of the length of the costal edge of the valvae. Initially, we followed this method in the present work (Fig. 1).

Unpaired two-tailed Student's *t*-tests were used to determine whether samples from the studied populations differ significantly in average relative length of the spined ridge of the valvae. Significance was accepted when  $p < 0.01$ .

Finally, we measured a larger number of quantitative parameters to perform a cluster analysis for a higher reliability and better visualization. The following parameters were used: L – length of the spined ridge of the valva, expressed in per cent of the total length of the costal edge of the valva;  $L_{fw}$  – length of the forewing; C – curvature of the dorsal edge of the spined ridge of the valva, of negative value if the edge is concave,



**Fig. 1.** Male valva of *E. dabanensis*, showing method used for measurements. Distance "A" is the length of the costal edge of the valva, measured from the point where the vertical process of the basal end meets the costa to the tip. Distance "B" is the length of the spined ridge of the valva.  $\frac{B \times 100}{A} = L$ , where "L" is the relative length of the spined ridge of the valva expressed in per cent. Distance "C" indicates the curvature of the dorsal edge of the spined ridge of the valva.

positive if the edge is convex. Population averages of  $L$ ,  $L_{fw}$  and  $C$  are shown in Table 1. A hierarchical cluster analysis (single linkage method, based on the matrix of Euclidean distances) was carried out to identify groups of similar populations. Prior to doing so, the population parameters ( $L$ ,  $L_{fw}$  and  $C$ ) were  $z$ -transformed (mean = 0, standard deviation = 1) to exclude influences of different scaling. All calculations were performed using the software package STATISTICA (StatSoft 1995).

### 1.3. Results

Troubridge & Philip (1983) demonstrated that in Nearctic specimens of *E. youngi* the length of the spined ridge of the valva, expressed in per cent of the total length of the costal edge of the valva, averages 43 % (range 36–47 %), while in Palaearctic specimens of *E. dabanensis* it averages 55.8 % (range 47–67 %). Our aims were: a) to determine if these differences could be used for the sure diagnosis of the Palaearctic specimens of *E. youngi* and of *E. dabanensis*; and b) to check for the possible existence of a cline in this parameter toward *E. youngi* throughout the distribution area of *E. dabanensis*.

The data presented in Table 1 demonstrate quite clearly that the length of the spined ridge of the valva could be used as a good taxonomic character to differentiate *E.*

**Table 1.** Morphometric data of male *E. youngi* and *E. dabanensis*. N – number of specimens examined. L – length of the spined ridge of the valva in male genitalia, expressed as per cent of the total length of the costal edge of the valva.  $L_{fw}$  – forewing length. C – curvature of the dorsal edge of the spined ridge of the valva; negative value if the edge is concave, positive if the edge is convex.

Species	Locality	N	Range of L (%)	Average L (%)	Average $L_{fw}$ (mm)	Average C (mm)
<i>E. youngi</i>	Yukon	7	40.47-53.49	48.8	21.8	2.4
	NE Chukotka	5	43.05-50.63	46.7	19.3	2.3
	Average for species			47.7	20.5	2.3
<i>E. dabanensis</i>	NW Chukotka	10	57.69-67.39	61.8	20.2	-2.0
	Magadan region	13	56.25-64.71	61.5	22.1	-2.1
	NE Transbaikal	10	60.00-71.70	64.0	21.6	-2.0
	S Transbaikal	10	58.33-66.66	62.9	20.5	-2.2
	E Sayan	10	54.00-64.00	59.4	20.9	-1.9
	Putorana plateau	6	46.65-56.82	51.7	19.9	-1.1
	Polar Ural	10	53.19-66.07	56.6	20.8	-1.4
Average for species			56.9	20.6	-0.9	

*youngi* from *E. dabanensis* in most cases. By this parameter, there is no noticeable cline leading from the West to the East from *E. dabanensis* into *E. youngi* throughout the giant area of the distribution of *E. dabanensis*. An opposite pattern occurs: the length of the spined ridge of the valva in *E. dabanensis* first decreases towards the west with the minimum found in the population of the Putorana plateau. Then, further west it increases again in the population of the Polar Ural.

Statistical analysis of data on relative lengths of the spined ridge of valvae (Table 2) demonstrates that differences in means between populations of *E. dabanensis* and *E. youngi* are significant, with one single exception. By this parameter, *E. dabanensis* from the Putorana plateau is indistinguishable from *E. youngi* from the NE Chukotka and Yukon.

Thus, the length of the spined ridge of the valva could not be used alone as the ultimate means to separate *E. dabanensis* from *E. youngi*. Otherwise, one should consider the population of the Putorana plateau as belonging to *E. youngi*. This is highly improbable, taking into account the large distance (ca. 3800 km) between the Putorana population and the nearest locality of *E. youngi* at NE Chukotka, without any linking populations (with the same valva morphology) in between.

We found additional specific differences in the male genitalia of *E. dabanensis* and *E. youngi*. In *E. youngi* the whole valvae are relatively shorter than in *E. dabanensis* in specimens of similar size (cf. Figs. 4–5 with Fig. 3). To check this, we measured the

Species	Locality	<i>youngi</i> Yukon	<i>youngi</i> NE Chukotka	<i>dabanensis</i> NW Chukotka	<i>dabanensis</i> Magadan region	<i>dabanensis</i> NE Transbaikal	<i>dabanensis</i> S Transbaikal	<i>dabanensis</i> E Sayan	<i>dabanensis</i> Putorana
<i>youngi</i>	NE Chukotka	0.355	–						
<i>dabanensis</i>	NW Chukotka	<0.001	<0.001	–					
<i>dabanensis</i>	Magadan region	<0.001	<0.001	0.797	–				
<i>dabanensis</i>	NE Transbaikal	<0.001	<0.001	0.198	0.071	–			
<i>dabanensis</i>	S Transbaikal	<0.001	<0.001	0.493	0.230	0.450	–		
<i>dabanensis</i>	E Sayan	<0.001	<0.001	0.121	0.081	0.006	0.016	–	
<i>dabanensis</i>	Putorana	0.224	0.041	<0.001	<0.001	<0.001	<0.001	0.002	–
<i>dabanensis</i>	Polar Ural	0.004	<0.001	0.013	0.010	<0.001	0.003	0.131	0.039

**Table 2.** Results of Student' *t*-tests of differences in relative length of the spined ridge of the valvae (in male genitalia) between examined populations of *E. youngi* and *E. dabanensis*. Significant differences ( $p < 0.01$ ) are printed in bold.

forewing length, as parameter to characterise the size of the specimen, in the same specimens of which the valvae had been measured. Furthermore, the following features in the structure of the male genitalia could serve well to distinguish *E. youngi* and *E. dabanensis*. As already stated by Troubridge & Philip (1983), the most significant structural difference between *E. youngi* and *E. dabanensis* is in the male valva. That of *E. dabanensis* has a much longer, more pointed or narrower tip than that of *E. youngi*. Moreover, in *E. dabanensis* the dorsal edge of the spined ridge of the valva is almost always concave (as in Figs. 1 & 3); only rarely it is straight. In *E. youngi* this spined ridge is almost always more or less convex (Figs. 4, 5) and again very rarely straight. In Nearctic specimens of *E. youngi* this dorsal edge it is always convex (K. Philip and J. Troubridge, pers. comm.).

The cluster diagram (Fig. 2) based on forewing length, as well as curvature and length of the dorsal edge of the spined ridge of the valvae demonstrates clearly that all examined populations are separated into two clear main groups. In one group are united all Palaearctic populations from the Polar Ural to NW Chukotka, in the other group are united the Palaearctic population of NE Chukotka and the Nearctic ones from the Yukon Territory. This phenetic result supports well the hypothesis of specific distinctness of *E. dabanensis* and *E. youngi*. The fact that the group of populations of *E. dabanensis* looks as quite heterogeneous, is not surprising taking into account the giant area of its distribution. It ranges across ca. 4200 km from Polar Ural to NW Chukotka, forming a number of named subspecies.

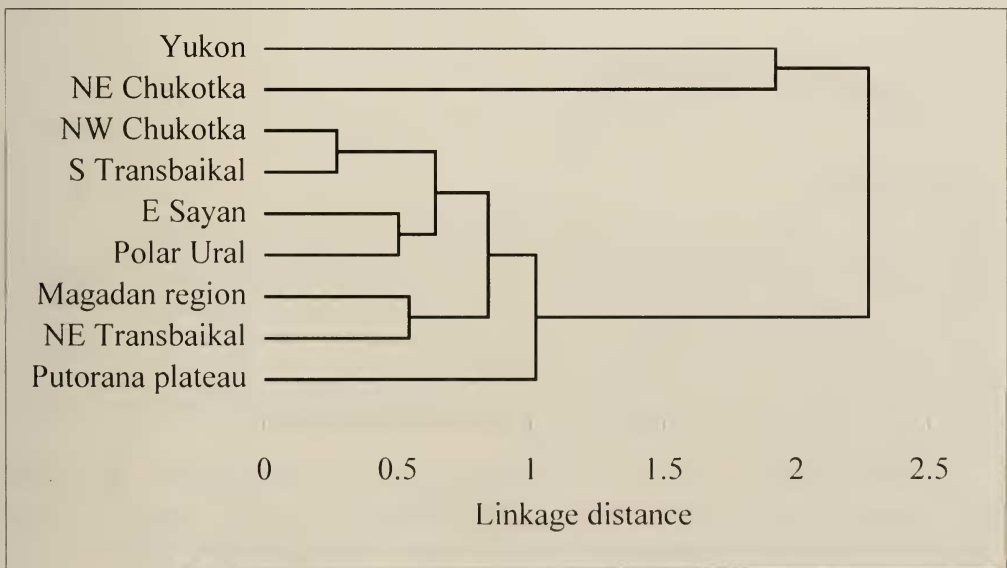


Fig. 2. Phenetic cluster diagram of *E. youngi* and *E. dabanensis* populations from different localities (three variables, Euclidean distances, agglomeration algorithm: single linkage).

**Table 3.** Morphometric data of male *E. occulta* and *E. anyuica*. N – number of specimens examined. L – length of the spined ridge of the valva in male genitalia, expressed as per cent of the total length of the costal edge of the valva.  $L_{fw}$  – forewing length. C – curvature of the dorsal edge of the spined ridge of the valva; negative value if the edge is concave, positive if the edge is convex.

Species	Locality	N	Range of L (%)	Average L (%)	Average $L_{fw}$ (mm)	Average C (mm)
<i>E. occulta</i>	Yukon	19	65.31 - 75.56	70.2	19.7	-1.7
	NE. Chukotka	4	71.82 - 77.57	74.1	19.3	-0.9
	Average for species			72.1	19.5	-1.3
<i>E. anyuica</i>	NW. Chukotka	3	62.00 - 65.52	64.3	22.3	-1.7
	Magadan region	12	54.90 - 63.93	60.9	23.1	-0.3
	Yakutiya	5	58.00 - 60.00	57.6	22.0	1.3
	NE. Transbaikal	11	55.17 - 65.52	60.6	22.7	1.0
	S. Transbaikal	10	59.65 - 65.52	63.2	23.6	0.9
	E. Sayan	11	56.00 - 64.15	61.2	22.0	0.5
	Average for species			61.3	22.6	0.3

#### 1.4. Conclusion

Summarising the aforementioned arguments, we conclude that *E. youngi* is a *bona species*, separated morphologically from the very closely related species *E. dabanensis*. Further investigations in the interior regions of Chukotka should reveal whether there is some natural boundary between *E. dabanensis* and *E. youngi*, or whether there a narrow intermediate zone exists where these two species might occur in sympatry. All literature records of *E. dabanensis* from East Chukotka should be considered as doubtful so far; perhaps they refer to *E. youngi*.

We cannot judge yet about the subspecific status of the NE Chukotkan population of *E. youngi*. First, the number of available specimens is still low. Second, we have insufficient comparative material of all three known North American subspecies of *E. youngi* available to study. Finally, the status of the taxon *tshuktscha* Herz, 1903 remains uncertain. It was originally described as a “variety” of *E. dabanensis*, based of a single specimen taken at Provideniya Bay (NE Chukotka). From the original description alone it is impossible to decide to which species of the *E. dabanensis* complex this taxon should belong. Unfortunately, the first author (A.B.) has not yet found the type



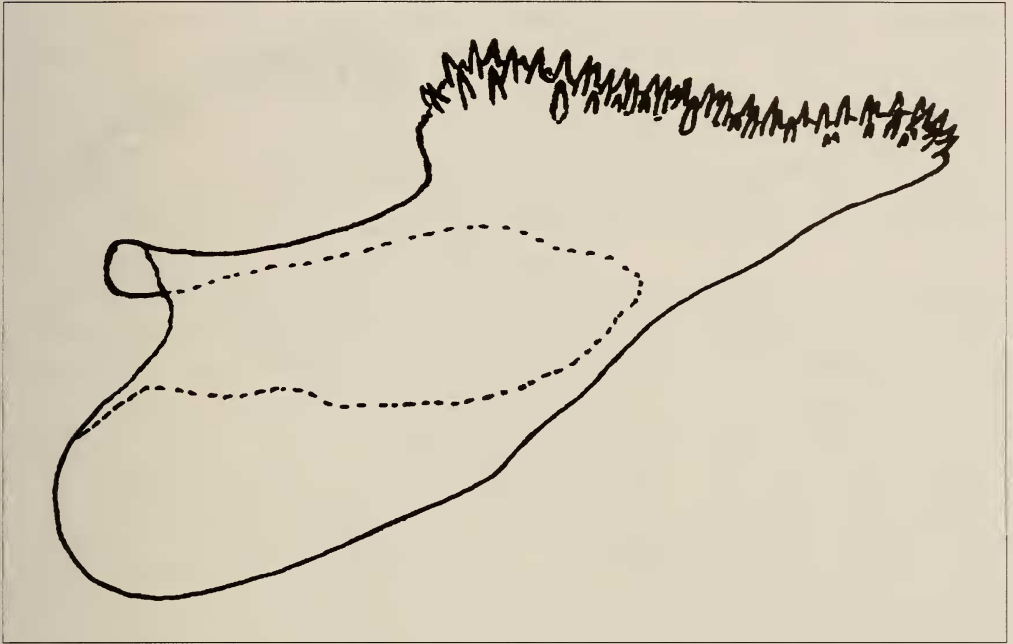


Fig. 3. *E. dabanensis*, male, left valva, lateral view. Russia, Chita region, Kyra district, Sokhondo Mts., ca. 67 km WNW of village Kyra, upper stream of Bukukun river, 1990–2025 m, 18.VI.1999, A.G. Belik leg.

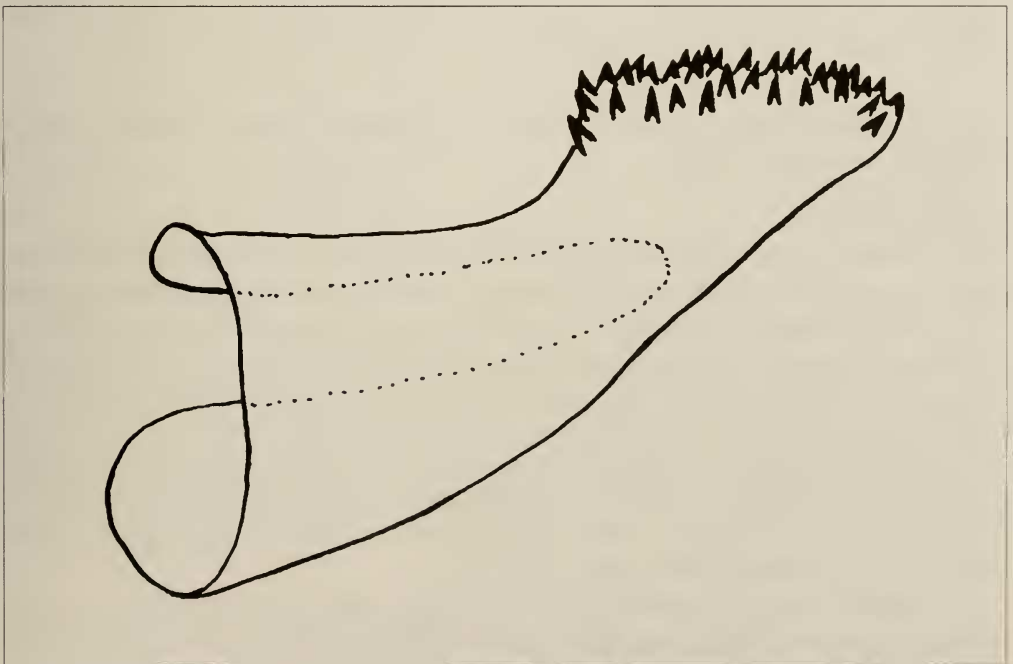


Fig. 4. *E. youngi*, male, left valva, lateral view. Russia, NE. Chukotka, 20 km SE of lake Ioni, valley of Gil'miml'veem river, 22.VII.1998, D.G. Zamolodchikov leg.

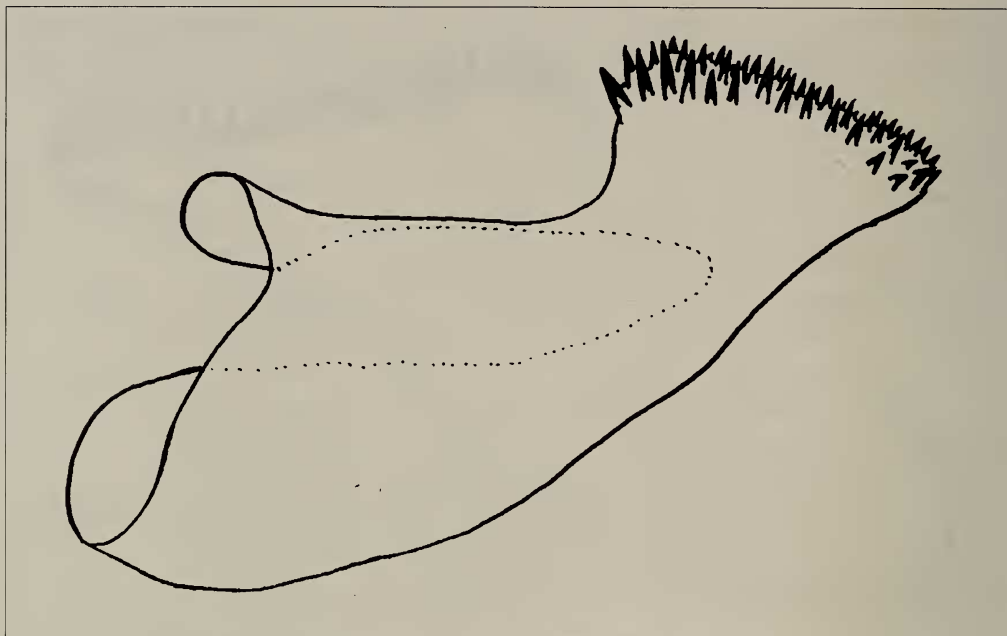


Fig. 5. *E. youngi*, male, left valva, lateral view. Canada, Yukon Territory, Nickel Creek, 4200 ft., 28.VI.1987, M.L. Grinnell leg.

specimen of *E. dabanensis tschuktscha* in the collections of Zoological Institute of the Russian Academy of Sciences (St. Petersburg) where it should be deposited.

## 2. *E. anyuica* Kurentzov, 1966 and *Erebia occulta* Roos & Kimmich, 1983 (= *phellea* Philip & Troubridge, 1983).

### 2.1. Introduction

Our discovery in NE Chukotka is the first proven record of the putatively endemic Nearctic species *E. occulta* for the Palaearctic region. All previous literature records of *E. occulta* from the Palaearctic in fact referred to *E. anyuica* Kurentzov, 1966 (= *anyuka*, *anjuika*, *anjuica* auct.) (Troubridge & Philip 1983; Tuzov 1993; Korshunov & Gorbunov 1995; Korshunov 1996; Tuzov *et al.* 1997; Streltsov 1998; Korb 1999). And otherwise, all recent records of *E. anyuica* from the Nearctic referred to *E. occulta* (Layberry *et al.* 1998). All these records were based on the misinterpretation (or, on the lack of the sufficient proof) of the fact that *E. occulta* and *E. anyuica* are two separate species. In the present article, arguments are presented to support that *E. occulta* and *E. anyuica* are two different species.

*E. phellea* Philip & Troubridge, 1983 is a junior subjective synonym of *E. occulta* Roos & Kimmich, 1983 (Philip & Roos 1985). Korb's statement (1999), according to which Dubatolov (1992) synonymized *E. phellea* with *E. occulta*, is not true. Dubatolov (1992) placed *E. occulta* into the synonymy of *E. anyuica*, indeed. A further statement of Korb (*loc. cit.*) that *E. phellea* is a separate species, which occurs sympatrically

with *E. anyuica* and *E. occulta* at the same locality (*sic!*) near Magadan, is absolutely wrong. This author apparently was unaware of the individual variability both in the male genitalia structure and in the wing pattern and coloration. Moreover, he states that in *E. phellea* the valva were more than two times wider than the aedeagus, while in *E. occulta* the valva were of the same width as the aedeagus. On the figure of the male genitalia of *E. phellea* Korb refers to (Korb, 1999:1369, Fig. 2), it is obvious that the valva merely is flattened, the membrane of the interior side of the valva is spread, thus the valva looks so wide in the dorsoventral aspect.

The use of the name *E. anyuica* Kurentzov, 1966 constitutes a serious nomenclatural problem (Belik 1996). Though the solution of this problem is beyond the scope of the present paper, some comments are necessary here. The name was often attributed to some Palaearctic butterflies belonging to the *Erebia magdalena* species complex (Kogure & Iwamoto 1992; Tuzov 1993; Korshunov & Gorbunov 1995). There was also an attempt to apply the name *E. jakuta* Dubatolov, 1992 (*E. anyuica jakuta* Dubatolov, 1992 in the original combination) to the Palaearctic species previously considered as *E. occulta* (Korshunov 1998). We suggest that the name *E. anyuica* Kurentzov, 1966 should be used exclusively for the Palaearctic species that previously was considered as *E. occulta*. This is necessary for the stability of the nomenclature and to finish the permanent confusion derived from the application of the name to butterflies belonging to very different species groups of the genus *Erebia* Dalman, 1816. A thorough investigation of Kurentzov's collection (deposited at the Institute of Biology and Pedology of the Russian Academy of Sciences, Vladivostok) should be undertaken to find out if there are left any remains of the single type specimen (holotype by monotypy) of *E. anyuica*, which specimen is presumed to be lost (Azarova 1986).

The recent designation of a neotype of *E. anyuica* (Korb 1999) must be considered as premature and invalid. It does not meet the requirement of ICZN, which allow a designation of a neotype: ICZN (1999) Art. 75.3.4. Korb's reasons for believing the holotype is lost are based exclusively on the report of Azarova (1986). Korb did not take any steps to reinvestigate Kurentzov's collection to trace the holotype. Meanwhile, there exists a specimen in Kurentzov's collection (quite worn, without abdomen, as the genitalia were presumably dissected, and with no type label), which could be the holotype of *E. anyuica* (Yu. Chistyakov, pers. comm.). Further, there exists a separate stock of genitalia preparations in Kurentzov's collection, where the genitalia of the holotype could be stored (V. Dubatolov, pers. comm.). Yet, nobody has checked this storage with the special aim to find the genitalia of *E. anyuica*. At last, though Korb states "the neotype is forwarded to Zoological Institute of Russian Academy of Sciences (St.-Petersburg)" (Korb 1999), he did not forward it there in fact, so far (A. Lvovsky, pers. comm.).

## 2.2. Material examined and methods

19♂ Canada, Yukon Territory, Richardson Mts., Dempster Hwy., km 416–466; 4♂ Russia, NE Chukotka, 20 km SE of lake Ioni, valley of Gil'mimleveyem river; 2♂ Russia, NW Chukotka, Bilibino district: ca. 10 km NW of Bilibino; 1♂ Anyuyskiy mtn. range, vic. of Stadukhino; 12♂ Russia, Magadan region, Khasyn district, vicinity of Palatka; 1♂ Russia, Sakha-Yakutiya republic: Oymyakon district, ca. 58 km

WSW of Oymyakon, at the confluence of Suntar and Agayakan rivers; 4♂ Tompo district, ca. 180 km ENE of Khandyga, Suntar-Khayata mtn. range, upper stream of Khandyga river; 11♂ Russia, Chita region, Udokanskiy mtn. range, 20–26 km SE of Udokan, upper stream of Naminga river; 10♂ Russia, Chita region, Kyra district, ca. 67 km WNW of village Kyra, Sokhondo Mts., upper stream of Bukukun river; 10♂ Russia, Buryat republic, East Sayan Mts., Kitoyskiye Gol'tsy mtn. range, between the sources of Irkut and Kitoy rivers, vicinity of Il'chir lake.

When studying the male genitalia of *E. anyuica* and *E. occulta*, we noticed that in *E. anyuica* the spined ridge of the valvae is relatively shorter than in *E. occulta*. So, we initially used the method of Troubridge & Philip (1983) to compare the length of the spined ridge of the valvae (in male genitalia) expressed in per cent of the length of the costal edge of the valvae (Fig. 1). Statistical comparisons of *E. anyuica* and *E. occulta* populations were performed as described above using *t*-tests and a cluster analysis (see chapter 1.2.).

### 2.3. Results

Troubridge & Philip (1983) demonstrated that in *E. occulta* the length of the spined ridge of the valvae, expressed in percents of the total length of the costal edge of the valvae averages 67.2 % (range 62–72 %). However, these authors were unaware of the possible specific independence of the Palaearctic butterflies that they considered as *E. occulta*, too. Their measurements of the valvae of both the Nearctic and Palaearctic specimens are mixed together in the published value (K. Philip, pers. comm.). So, from the mentioned work nothing can be taken as to possible differences between *E. occulta* and *E. anyuica*. Later it was stated, without any sufficient proof, that the difference of the male genitalia of *E. occulta* from the male genitalia of "*E. jakuta*" is "so noticeable that there is no need for explanations" (Korshunov 1998).

Thus, our aims were as follows. First, to determine if there are some stable differences between the male genitalia of *E. occulta* and *E. anyuica*, which could be used for the sure diagnosis of the Palaearctic specimens. Second, to check the possible existence of a cline toward *E. occulta* throughout the area of the distribution of *E. anyuica*.

The data presented in the Table 3 demonstrate clearly that the length of the spined ridge of the valva can be used as a good taxonomic character to differentiate *E. occulta* from *E. anyuica* in most cases. There is no noticeable cline leading from the West to the East from *E. anyuica* to *E. occulta* throughout the huge range of *E. anyuica*, spanning about 3750 km between the known westernmost (E Sayan) and easternmost (NW Chukotka) populations of *E. anyuica*. The length of the spiny ridge of the valva is almost constant throughout the range of the species (Table 3). At the same time, the distance between the known easternmost population of *E. anyuica* at NW Chukotka and the newly discovered population of *E. occulta* at NE Chukotka is just about 860 km. However, there is a clear difference in the length of the spined ridge of the valvae between these populations. Statistical analyses of data on relative lengths of the spined ridge of valvae (Table 4) demonstrates that the differences in means between populations of *E. anyuica* and *E. occulta* are significant without exceptions. This leaves no doubt that *E. anyuica* and *E. occulta* should be considered as separate species.

Further, we tried to find more parameters to separate *E. anyuica* and *E. occulta*. First, we noticed that in *E. anyuica* the whole valvae are relatively shorter than in *E.*

**Table 4.** Results of Student' *t*-tests of differences in relative length of the spined ridge of the valvae (in male genitalia) between examined populations of *E. occulta* and *E. anyuica*. Significant differences ( $p < 0.01$ ) are printed in bold.

Species	Locality	<i>E. occulta</i> Yukon	<i>E. occulta</i> NE Chukotka	<i>E. anyuica</i> NW Chukotka	<i>E. anyuica</i> Magadan region	<i>E. anyuica</i> Yakutia	<i>E. anyuica</i> NE Transbaikal	<i>E. anyuica</i> S Transbaikal
<i>E. occulta</i>	NE Chukotka	0.036	–					
<i>E. anyuica</i>	NW Chukotka	<b>0.008</b>	<b>0.003</b>	–				
<i>E. anyuica</i>	Magadan region	< <b>0.001</b>	< <b>0.001</b>	0.084	–			
<i>E. anyuica</i>	Yakutia	< <b>0.001</b>	< <b>0.001</b>	<b>0.007</b>	0.049	–		
<i>E. anyuica</i>	NE Transbaikal	< <b>0.001</b>	< <b>0.001</b>	0.057	0.845	0.058	–	
<i>E. anyuica</i>	S Transbaikal	< <b>0.001</b>	< <b>0.001</b>	0.350	0.044	< <b>0.001</b>	0.023	–
<i>E. anyuica</i>	E Sayan	< <b>0.001</b>	< <b>0.001</b>	0.099	0.787	0.027	0.638	0.069

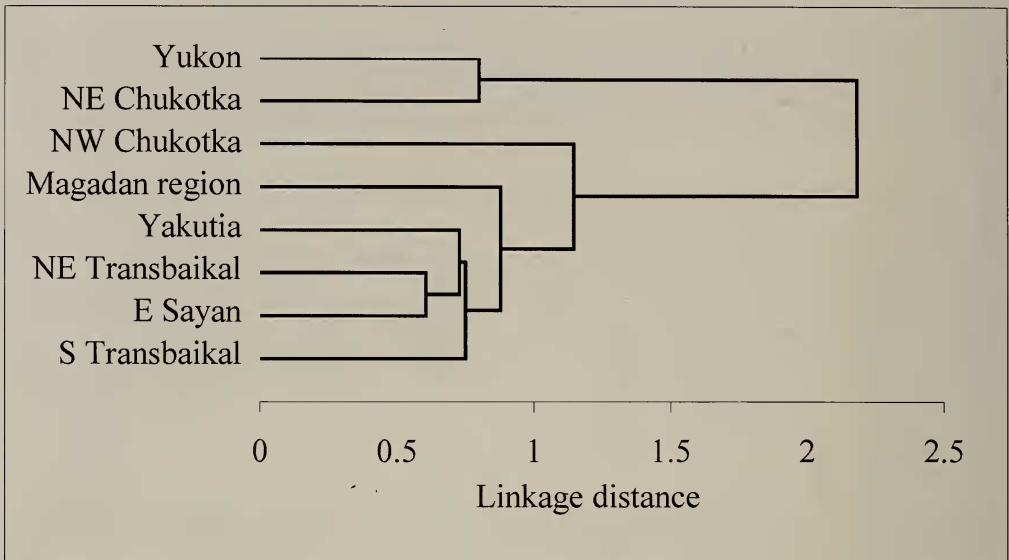
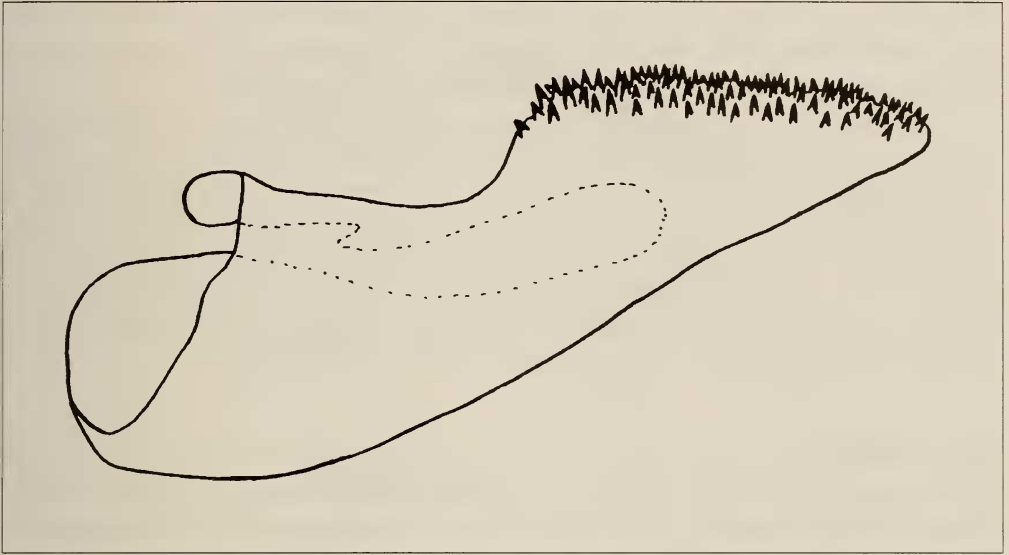


Fig. 6. Phenetic cluster diagram of *E. occulta* and *E. anyuica* populations from different localities (three variables, Euclidean distance, single linkage).

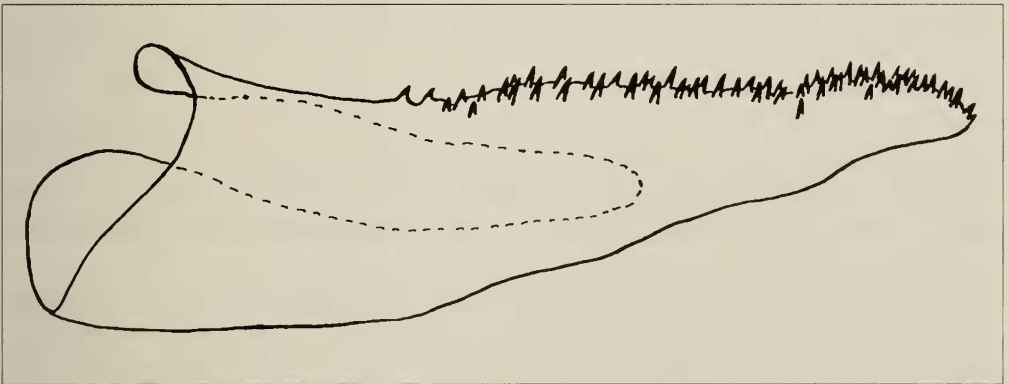
*occulta*, if body size of the butterflies (measured as forewing length) is controlled for. There is one more difference between the male genitalia of *E. occulta* and *E. anyuica* that was never mentioned in the literature before. We noticed that in the Nearctic specimens of *E. occulta* the dorsal edge of the spined ridge of the valva almost always forms an obtuse angle with the remaining spineless part of the dorsal edge of the valva (Fig. 9). In contrast, in *E. anyuica* the dorsal edge of the spined ridge of the valva almost always runs in parallel with the spineless part of the dorsal edge of the valva (Fig. 7).

Differences in wing pattern and coloration support the idea about the specific distinctness of *E. occulta* and *E. anyuica*. This is especially well seen in males. Throughout the range of *E. anyuica* from E Sayan to NW Chukotka there is a cline in the degree of the development of the fulvous submarginal elements in the forewings. Thus, the most developed fulvous ocelli that often are united in an almost uninterrupted band (on the upperside) and the most developed and wide submarginal band (on the underside) occur in specimens from the western part of the range (Belik 1996: 160, pl. 1, figs. 1–8). In specimens from the eastern part of the species range all these submarginal pattern elements are strongly reduced (Tuzov *et al.* 1997: 359, pl. 49, figs. 25–27). At the easternmost limit of the species range (NW Chukotka: Bilibino district), these submarginal pattern elements are practically absent at all, both on the upper- and underside of the fore- and hindwings. Thus, the specimens (only a few males are known) look totally black, sometimes with almost invisible traces of the submarginal spots on the forewings.

In the specimens of *E. occulta* from NE Chukotka, in contrast, the fulvous submarginal elements on the forewings are normally developed, with the same range of vari-



**Fig. 7.** *E. anyuica*, male, left valva, lateral view. Russia, Chita region, Udokanskiy mtn. range, 23 km SE of Udokan, upper stream of Naminga river, 1405 m, 16.VII.1998, A.G. Belik leg.



**Fig. 8.** *E. occulta*, male, left valva, lateral view. Russia, NE. Chukotka, 20 km SE of lake Ioni, valley of Gil'miml'veem river, 400 m, 12.VII.1998, D.G. Zamolodchikov leg.

ations as in specimens of *E. occulta* from North America. If a cline were to exist from *E. anyuica* to *E. occulta* in the Palaearctic, then we would expect to see a gradual transition in the wing pattern and coloration from one form into the other. This is definitely not the case.

Finally, any male specimen of *E. occulta* can be distinguished, more or less easily, from any male specimen of *E. anyuica* by the appearance of the hindwing underside. In *E. occulta*, the general appearance of the hindwing underside looks as more or less mottled with some dark grey cast. This is due to light hair-like scales (white to creamy tan) covering the surface and to the high proportion of pearl grey scales across the

entire wing. In *E. anyuica* the general appearance of the hindwing underside is much more monotonous, sooty blackish-brown or black. The hairs covering the surface of the wing are dark (brown to black) and pearl grey scales are absent.

The phenogram resulting from the cluster analysis (Fig. 6) clearly demonstrates that all examined populations split into two main groups. In one group are united all the Palaearctic populations from E Sayan to NW Chukotka, in the other group are united the Palaearctic population of NE Chukotka and the Nearctic ones from the Yukon Territory. This supports well the hypothesis of specific distinctness of *E. anyuica* and *E. occulta*. That the populations of *E. anyuica* look quite heterogeneously is not much surprising, taking into account its huge range across ca. 3750 km, from E Sayan to NW Chukotka, where *E. anyuica* forms a number of subspecies.

## 2.4. Conclusion

Summarising all preceding evidence, we conclude that *E. occulta* is a *bona species*, separated morphologically from its close relative *E. anyuica*. Further investigations in the interior regions of the Chukotka should reveal whether there is some natural boundary between *E. anyuica* and *E. occulta*, or whether there is some narrow intermediate zone where these two species could occur in sympatry. We have some hints that *E. occulta* is distributed throughout the whole Chukotskiy Peninsula. First, K. Philip reported (pers. comm.) that in the collection of the Alaska Lepidoptera Survey there is a series of specimens from the mouth of Cheutakan river (65° 38–39' N, 176° 51' W). These specimens look almost like Seward Peninsula (Alaska) material, instead of resembling the rather distinct form from the Magadan region, which in fact is *E. anyuica*. Second, the specimen of “*E. tundra*” from Egvekinot (ca. 250 km NW from the mouth of Cheutakan river), figured by Kogure & Iwamoto (1993), likely belongs to *E. occulta*, but the exact determination is impossible without checking both the wing underside and the structure of male genitalia.

At present, we cannot judge about the subspecific status of the NE Chukotkian population of *E. occulta* with full certainty (because of the low number of available specimens). There is the good probability that it belongs to the nominotypical subspecies. Troubridge & Philip (1983) demonstrated that in North America the variation from the Richardson Mts. (Canada: Yukon) to the Seward Peninsula (USA: Alaska) does not warrant naming the extremes as subspecies. Specimens from NE Chukotka are quite similar to those we have from Yukon for comparison. On the other hand, in some specimens of *E. occulta* from NE Chukotka the shape of the valvae in the male genitalia is quite different from that of *E. occulta* from Yukon (cf. Fig. 8 with Fig. 9). In the Chukotkian specimens occurs a tendency to complete reduction of the heel-like projection in the distal part of the spined ridge of the valvae, while the spined ridge itself is longer than in Nearctic specimens and runs in parallel to the costal edge of the valva. This might even be used as morphological argument for a separation of the Chukotkian populations of *E. occulta* as a distinct species, but such an action is absolutely premature. We have studied male genitalia of but four specimens from NE Chukotka. Moreover, we had no specimens of *E. occulta* from Alaska to study the





Fig. 9. *E. occulta*, male, left valva, lateral view. Canada, Yukon Territory, Richardson Mts., Dempster Hwy., km 466, 3400 ft., 18.VI.1993, M.L. Grinnell leg.

variation in the male genitalia in that part of its range, which is closest to Chukotka. More material of *E. occulta* from Chukotka should first be studied to clarify the range of its variation there. Finally, it should be emphasized that our findings of *E. occulta* and *E. youngi* in Chukotka, the first records of these putatively Nearctic species from the entire Palaearctic region, add two further cases to the growing list of species with trans-Beringian ranges.

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